Sub-Surface Molecular Investigation in Turbid Art Materials using Raman Spectroscopy

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Abstract

The recent advances in Raman spectroscopy that are paving ways to novel analytical approaches for improving the knowledge and conservation of art objects will be presented. Cultural Heritage materials are intrinsically complex and their non-invasive investigation is a major challenge for conservation scientists. One of major outstanding and only partially addressed needs in the conservation and material sciences is the non-destructive and non-invasive analysis of subsurface components with molecular specificity at micrometre scales. This capability is just in part fulfilled by confocal Raman microscopy, since its depth-resolving power is restricted to depths at which sample is transparent or semi-transparent. In case of highly diffusely scattering layers, i.e. painted stratigraphies, the restriction can be very severe and, although it is highly undesirable and in many cases impossible with precious objects of art cross section sampling becomes the only available recourse.

Over the last few years, Micro Spatially Offset Raman Spectroscopy (Micro-SORS) has been developed at the CNR-ISPC Raman laboratory and proposed as an effective tool for investigating non-invasively compounds located below the surface, for instance, in a hidden painted layer, in the preparation layer or in the substrate (i.e. plaster) [1,2]. This is crucial for deeper understanding of the micro-stratified systems, often encountered in paintings or in decayed materials. The applicability of micro-SORS has been demonstrated conceptually in several application areas including stratified polymers, glossy papers, layered materials in food analysis [3] and, in particularly, Cultural Heritage materials where a first portable micro-SORS prototype has been also used to investigate, non-invasively and *in-situ*, the layer sequence of a painting by Marco d'Oggiono of the Pinacoteca di Brera collection [4].

The results of a recent study carried out in collaboration with the University of Nottingham will be also shown, where micro-SORS has been coupled with Time-Gated Raman Spectral Multiplexing, enabling fast sub-millimeter resolution molecular depth Raman mapping of both fluorescing and non-fluorescing samples [5].

The principles of the abovementioned Raman techniques, the existing instrumental modalities, their capabilities and limitations as well as impact in Cultural Heritage will be discussed.

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